Restoring Degraded Soils in India using Urban Wastes

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Keane Shore

[Photo: Testing the fly ash-sewage sludge mixture.]

It may be the ecological equivalent of turning lead into gold.

Canadian and Indian researchers are combining fly ash from electricity generating plants, municipal sewage sludge, and — in some cases — the water hyacinth plant to produce a potent soil replacement for Indian communities. Each of these, on its own, is an environmental menace. Together, they could hold huge benefits for worn-out soil.

Raw materials

The background is this: coal-fired turbines generate four-fifths of India's electricity. The 200 million tonnes of low-grade coal that they burn each year discharge up to 100 million tonnes of fly ash into enormous settling ponds, causing siltation, flooding, and contamination of water sources for millions of people. (Harder grades of coal used in North America burn more cleanly, generating only about two percent fly ash waste by weight.) As well, every city in India produces huge amounts of mostly untreated sewage sludge, another water contamination risk. Finally, water hyacinth, a free floating weed introduced from South America before 1900, now infests an estimated 200,000 hectares of Indian waterways, choking off plant, fish, and animal growth.

Yet mixing the three materials creates a tonic, rather than a toxic, for soils where nothing has grown for a century or more, says Mike Powell of the University of Western Ontario. Dr Powell is one of the lead investigators on the Land Restoration through Waste Management project, funded by the International Development Research Centre (IDRC), the Canadian International Development Agency (CIDA), the India-Canada Environment Facility (ICEF), and the Indian Institute of Technology, where his counterpart is Dr Subhasish Tripathy.

Soil replacement

With some primary treatment, sewage sludge can be mixed with fly ash and sometimes hyacinth to yield more than just a fertilizer. Combining the sludge's nitrogen and organic matter with the minerals found in fly ash yields a potent soil replacement substance.

Fly ash does a lot for the soil, says Dr Powell. It reduces bulk density, increases water holding capacity, buffers pH (soil acidity), and adds both macro and micro nutrients. The major elements are potassium, phosphorus, calcium, magnesium, and carbon from unbound coal. Potential trace elements include boron, molybdenum, selenium, nickel, copper, zinc, and many exotic elements whose functions are not fully understood in plant physiology. The trick is getting just enough to be beneficial, but not enough to be toxic.

Applications

So far, the data show that vegetation grown on lands treated with this mix absorbs low levels of heavy metals. For now, the Indian private sector is using it to grow commercial tree species for plywood, and some sugar cane. Public-sector users have hopes to produce non-timber forest products for local villages, such as fuel wood, animal feed, medicinal plants, and grasses on marginal/wasteland and salt effected soils. The researchers have also planted small plots of edible crops to compare different ratios of ash and sludge, and to analyse the plants for metal uptake from the reconditioned soil.

All the data to date prove that the [amount of] metal uptake is within international guidelines, says Dr Powell. There are a couple of exceptions in the case of lead and chromium, but even these aren't far from the upper allowable limits. We are convinced this technology can be used on edible crops, but caution that we are still in the experimental phases.

Fly ash versus fertilizer

In certain badly depleted soils where climatic conditions and long use have eroded soil and leached out nutrients, the fly ash mix seems more effective than standard chemical fertilizers. But Dr Powell notes that it is tricky to compare it directly with chemical fertilizer in growing plots, because Indian planting programs hold so many variables.

In poorly operated programs where, say, eucalyptus trees get one application of chemical fertilizer at planting and no subsequent watering, only half of the trees may survive, growing to a spindly and useless few centimetres in diameter after seven years. With more careful planting and tending in good social forestry programs, harvest-ready trees can be produced in the same length of time. The question is whether or not this new technology produces higher yields in the same amount of time.

Biomass yields

I do not want to mislead anyone, says Dr Powell, (but) we have preliminary data to show that we will get around two to three times the biomass using our technology. He cautions that these are best-case results from a private-sector plot that combined sophisticated fertilizer and drip irrigation techniques. But if our feasibility study is any indication, we should get from a 50 to 100 % improved growth rate. This is only a prediction — we'll know much more by next year.

According to Dr Powell, social forestry schemes in India usually invest about 12,000 to 20,000 rupees (CA$420 to $700) to reforest each hectare with chemical fertilizers. By contrast, the fly ash mix costs about 30,000 to 60,000 rupees (CA$1,050 to $2,100) per hectare. However, the initial reforestation is a labour-intensive process, so it provides short-term local employment at the outset. Moreover, the trees grow bigger and perhaps twice as many live. By the time they mature, he suggests, a community can recoup its investment three or four times over. There's a real financial or economic benefit to using our material.

Supporters

Current supporters of this technology include the Cuttack Municipal Corporation, which is funding use of the fly ash mix; several Indian states including Orissa, Uttar Pradesh, and Madhya Pradesh; and dozens of villages rehabilitating their lands.

Dr Powell believes that once this research is further advanced in India, it could be applied around the world in countries that already use fly ash and sewage as soil supplements. Still, he cautions that the mix is no panacea. High transportation costs limit its suitability to communities near large cities like Calcutta, which have coal-fired power plants and plenty of sewage. He adds that much research and longer-term monitoring remains — to determine how the mix performs with different species of trees, plants, and agricultural crops, and to fully assess its potential.

Keane J. Shore is an Ottawa-based writer and editor. *(Photo: M. Powell)*

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If you have any comments about this article, please contact info@idrc.ca .

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